Thermodynamics of Nucleation in Current Carrying Conductors

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Recently we found that high density electric currents in the medium have strong effect upon the character of the phase transitions of the first kind if these phase transitions are accompanied by sharp change of electric conductivity. The mechanism of this effect is associated with the dependence of the inductance of an inhomogeneous conducting medium upon the size and location of a nucleus with a conductivity different from that of the surrounding phase. Since ponderomotive forces in the conducting medium act to increase its inductance they contribute into the work of formation of a nucleus which depends upon a size of a nucleus and its location. In this paper we summarize the main results of our research [1]-[4]:

- 1. Dependence of the temperature of the front of an equilibrium phase transition upon the amplitude of electric current.
- 2. Renormalization of the phase equilibrium curve during volumetric phase transition.

 We found that during equilibrium melting, when the dynamics of a phase transition front are determined by a heat balance, there exists a single-valued correlation between the rate of inductance change and a temperature at the phase transition front.
- 3. It is shown that there occurs splitting of the phase equilibrium curve into the two separate curves for the direct and inverse phase transitions. Depending upon the mutual location of both curves two opposite situations may occur. The first case is that of a regular hysteresis when there exists a domain of stability of both phases and the realization of a particular phase is determined by the initial conditions and the direction of the process. In the second case there exists a region where both phases are unstable. This region can be considered as a domain of the fragmentation of material into small particles. We determined various thermodynanic parameters: latent heat of phase transition, shift of the phase equilibrium curve and the size of the critical nucleus.
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- [3] Yu. Dolinsky and T. Elperin, J. Appl. Phys. **80**, 38 (1996).
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